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A method for developing images of clothes based on visual and tactile evaluations of "thickness" and "thinness"

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Abstract

The purpose of this study is to clarify the relationship between the visual and tactile evaluations of the "thickness" and "thinness" of a piece of fabric, and to develop photographs of pieces of fabric adapted to the described degree of "thickness" and "thinness" using the evaluation results. We carried out two fabric texture evaluation experiments, one using only visual perception (VE) and the other using both visual and tactile perceptions (VTE), for thinness and thickness using eleven types of actual fabric. Ten observers evaluated the thickness and thinness of the fabric samples using a 5-point scale. The results indicated that there were no significant differences between the VE and VTE evaluations. This result implies that visual recognition is predominant in fabric texture assessment. We then focused on the results of the VTE-based evaluations, which presented an overall judgment of fabric textures. Next, to expound on the method for developing photographs of fabric samples using these thickness and thinness evaluations, we focused on two physical properties: a light transmittance of the fabric as a visual factor, and a thickness parameter "T_0" in the Kawabata evaluation system as a tactile factor. The relationships between the evaluation results and the physical properties of the former and the latter were clarified by correlation analysis. The former exhibited a higher correlation than the latter in terms of a psychophysical relationship. We therefore focused on the light transmittance of the fabric samples, and developed and evaluated photographs that changed illumination levels to indicate the thickness and thinness levels. The results revealed that altering the photographs based on the aforementioned evaluations improved the accuracy of fabric texture recognition.

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Keywords: Thickness; Thinness; Visual; Tactile; Light transmittance, Luminance

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1. Introduction

In recent years, many people have begun using online shopping sites given their convenience and many benefits. For clothes shopping [1], the rate of online shopping tends to increase with the popularity of the fashion brand. However, the lack of improvement in the rejection rate of clothes is a limitation. One of the reasons for rejection is thought to be the inadequacy of the images used to represent clothes in conveying a visual impression and tactile perception of the actual fabric. In a previous study [2], we conducted an experiment involving blind-touch identification of an actual piece of fabric by observers who had looked at an image of the test piece. The results revealed that the fabric identification ratio, which was defined as number of rightly selected actual fabric for all presentation-images of the test piece, was related to fabric characteristics such as the surface properties, compression, and thickness. In another earlier study [3], we recorded and analyzed the words used by different observer groups to evaluate the clothes. This study revealed that the "thinness" and "thickness" of the fabric were important evaluation words in terms of both appearance and tactility.

The current study aims to clarify the relationship between the visual and tactile evaluations of the thickness and thinness of a piece of fabric, and use the evaluation results to develop photographs of pieces of fabric adapted to the described degree of thickness and thinness. Specifically, ten observers evaluated eleven types of fabric in terms of their thickness and thinness using a 5-point scale. Two types of evaluation experiments were conducted: one using only visual perception (VE) and the other using both visual and tactile perceptions (VTE). The results indicated that VE-based evaluations roughly corresponded with the VTE-based ones and no significant differences were found. This implies that visual recognition is predominant in fabric texture assessment, thereby reflecting a tendency similar to the one exhibited in our previous study. Subsequently, we focused on the results of the VTE-based evaluations, which presented an overall judgment of fabric textures. Next, to expound on the method for developing photographs of fabric samples using these thickness and thinness evaluations, we investigated the physical properties related to these evaluation results. We focused on two physical properties: a light transmittance of the fabric as a visual factor, and a thickness parameter "T_0" in the Kawabata evaluation system (KES) as a tactile factor. The relationships between the evaluation results and physical properties of the former and the latter were clarified by correlation analysis. The former indicated a higher correlation than the latter in terms of a psychophysical relationship. We therefore focused on the light transmittance properties of the fabric samples, and developed and evaluated the photographs that changed illumination levels to indicate the described thickness and thinness levels. The results revealed that altering the photographs using the aforementioned evaluation results improved the accuracy of fabric texture recognition.

2. Texture evaluation experiment using actual fabrics and the related physical properties of the fabrics

2.1. Conditions of the texture evaluation experiment

Eleven navy blue fabrics from the spring/summer 2014 trend were prepared for the texture evaluation experiment. A 20 cm × 20 cm square piece (the size of the conditioned weight at JISL1096 [4]) was cut from each fabric, and a small square tag was attached to the corner of each piece to indicate the top surface of the piece. Two types of evaluation experiments using actual fabrics were conducted using VE and VTE. In VE testing, thickness and thinness were evaluated using visual perception alone, whereas in VTE testing, thickness and thinness were evaluated using both visual and tactile perception. Visual distances were about 60 cm for both experiments. The two types of experimental environments are shown in Figure 1. For VE testing, the horizontal and vertical illuminances of the fabric stimuli were about 321 and 150 lx, respectively, while for VTE testing, they were about 269 and 137 lx, respectively. Thickness and thinness were rated separately on a 5-point unipolar rating scales (1: Bad, 2: Poor, 3: Fair, 4: Good, 5: Excellent). The participants were ten students in their twenties.

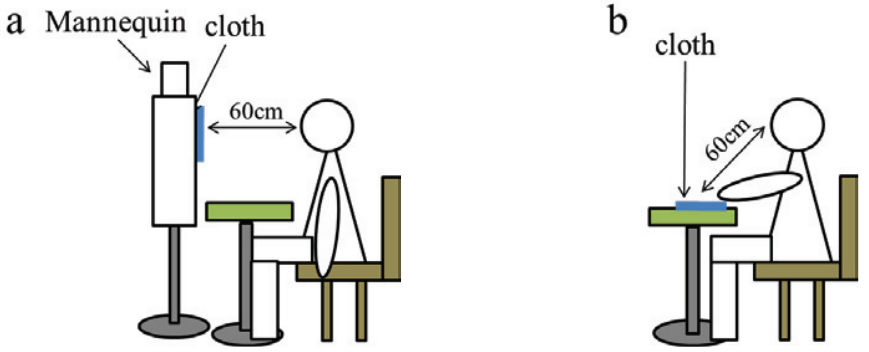

Fig. 1. Experimental environment for actual fabric (a) visual evaluation (VE) (b) visual and tactile evaluation (VTE).

2.2. Result of the texture evaluation experiment

Figure 2 shows the average thickness and thinness evaluation values from VE and VTE of the actual fabric samples. The correlation coefficients of the VE and VTE evaluation values for thickness and thinness are 0.85 and 0.84, respectively. Therefore, the evaluation value from VE is very similar to that from VTE for both thickness and thinness, which suggests that visual perception is very important for fabric texture recognition.

2.3. Physical properties related to the evaluation values

In order to reveal the method for developing photographs of fabric samples using the thickness and thinness evaluations, we investigated the physical properties related to the results of these evaluations. As fabric physical properties, we focused on the thickness parameter "T_0" [mm], a textile material property from the KES (Kawabata Evaluation System), and the light transmittance [%] of the fabric. The thickness parameter "T_0" was measured using a KES-FB3-AUTO-A (Kato Tech Co., LTD.). The light transmittance of the fabric was calculated from the luminance measured using a CA-2500 (Konica Minolta). To investigate the physical properties related to the thickness and thinness evaluation values, the correlation coefficients between these physical properties and the evaluation results were calculated and are shown in Table. 1. The light transmittance of the fabric exhibited a higher correlation than the thickness parameter "T_0". We therefore focused on the light transmittance of the fabric samples, and developed and evaluated the photographs that changed illumination levels to indicate the thickness and thinness levels.

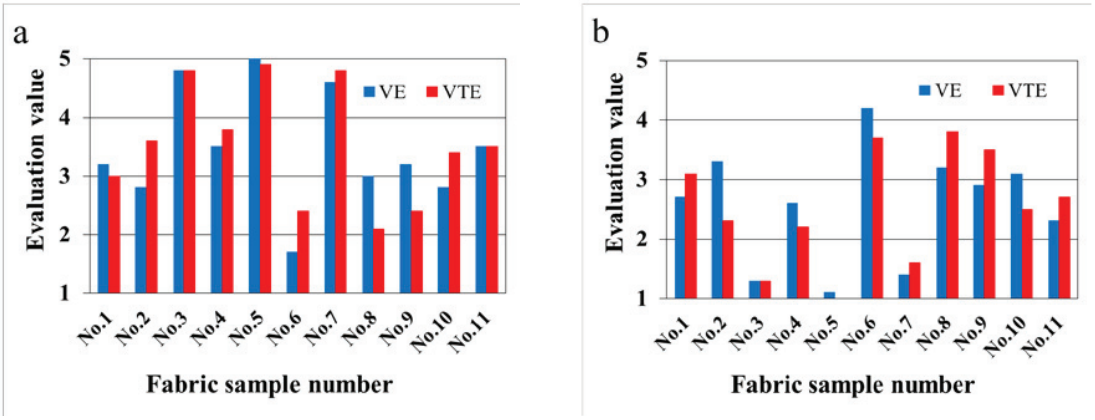

Fig. 2. Results of (a) thickness (b) thinness evaluations from VE and VTE of the actual fabric samples.

Table 1. Correlation coefficients between the physical properties and thinness and thickness evaluation values obtained by VE and VTE.

Physical properties	Evaluation Values			
	Thickness		Thinness	
	VE	VTE	VE	VTE
Thickness (T_0) parameter in KES	0.57	0.60	-0.58	-0.57
Light transmittance of the fabric	-0.83	-0.80	0.82	0.79

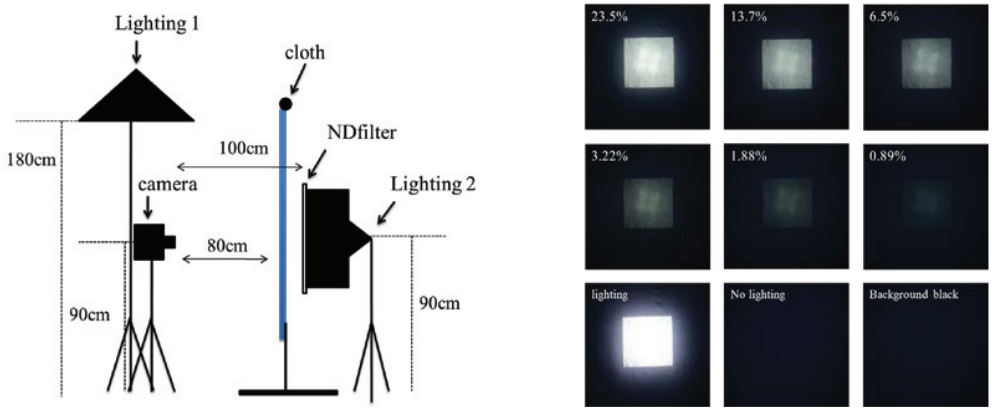

Fig. 3. (a) Setup of the photography equipment; (b) Presentation image (fabric sample No. 8).

3. Development and evaluation of images focusing on the light transmittance of the fabric

3.1. Conditions of photography and image development

The photography environment and examples of shot images are shown in Figure 3a and Figure 3b, respectively. The photographs of each fabric were taken using a Nikon D600 digital camera set at ISO 100, focal length 24 mm, shutter speed 1/13 s, and aperture F3.5, using a mounting lens: Nikon ED AF-S NIKKOR 24-85 mm. The lighting 1 level was set at constant, and the lighting 2 levels were discretely controlled using six neutral density (ND) filters with optical densities of 0.89%, 1.88%, 3.22%, 6.5%, 13.7%, 23.5%, respectively. Six photographs were taken under these lighting conditions. In addition, three photographs were taken under the following conditions: “lighting: only use lightings with no fabric”, “no lighting”, and “background black: use a black fabric as the background”. Hence, nine photographs were developed for each fabric.

3.2. Evaluation of developed images and photographic conditions of corresponding to the evaluation values of actual fabric

The participants evaluated the thickness and thinness of a fabric by observing the stimulus presented in a visual environment having horizontal and vertical illuminance of about 434 and 186 lx, respectively, at a 60 cm visual distance. Ninety-nine different fabric images were displayed. The evaluation scale and participants were the same as those for the texture evaluation experiment. To analyze the photographic images with respect to the corresponding evaluation results of the actual fabric, the differences in evaluation results between the actual fabric and the photographic images were calculated. The evaluation values of the developed images were subtracted from the evaluation results of VTE to obtain a correct overall judgment value of fabric texture. These differences were called the “evaluation error”. The evaluation error for VTE is shown in Figure 4. The evaluation error tends to decrease

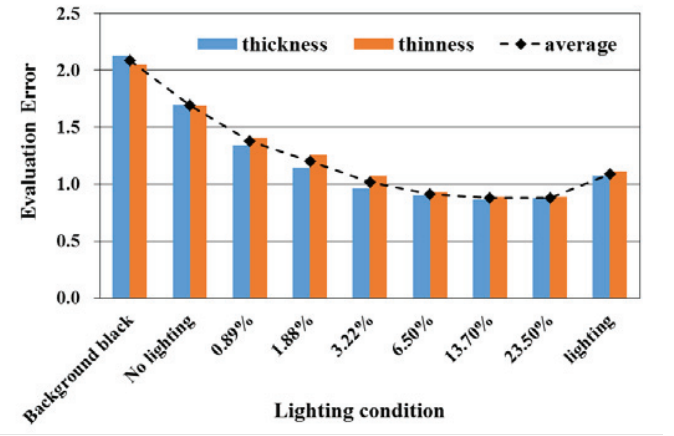

Fig. 4. Evaluation error in the case of VTE.

with decreasing lighting levels, with the minimum value obtained using a 13.7–23.5% ND filter. Therefore, these are the lighting conditions corresponding to the evaluation rating of the actual fabric. The luminance under these lighting conditions was measured for each fabric. As a result, a luminance-evaluation database relating to the average luminance of the photography image and its evaluation value for each fabric was obtained. The results suggest that fabric photographs taken by adjusting the lighting conditions to the proposed luminance for realizing an evaluation value based on this luminance-evaluation database will produce an evaluation rating of the same thinness and thickness as the evaluation rating of the actual fabric.

4. Conclusions

To develop a method of image presentation that can evaluate the thinness and thickness of a fabric, we conducted texture evaluations using actual fabrics, measured the fabric's physical properties, and considered the relationship between these results. In thinness and thickness evaluations using actual fabrics, the light transmittance of the fabric exhibited a higher correlation with the evaluation results of the actual cloth than the "T_0" thickness parameter. The evaluation error, calculated from the difference in the evaluation values of fabric images and actual fabrics, tends to decrease with decreasing lighting levels, with the minimum value obtained at 13.7–23.5%. This result suggests that the photography method used in this experiment can visually assess the thinness and thickness of the actual fabric.

Acknowledgements

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